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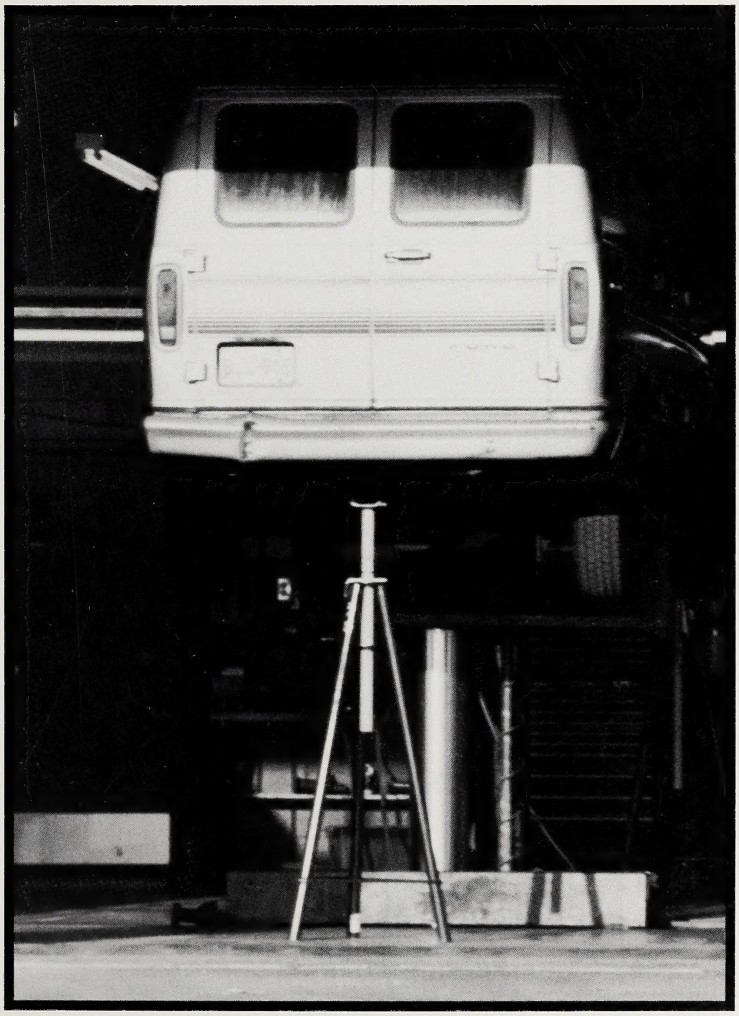

Module 2

Fluids and Pressure

Distance Learning

Alberta EDUCATION

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Science 9

Module 2

FLUIDS AND PRESSURE

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Student Module
Module 2
Fluids and Pressure
Alberta Distance Learning Centre
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Welcome to Module 2!

We hope you'll enjoy your study of Fluids and Pressure. To make your learning a bit easier, a teacher will help guide you through the material.

So whenever you see this icon,

turn on your audiocassette and listen.

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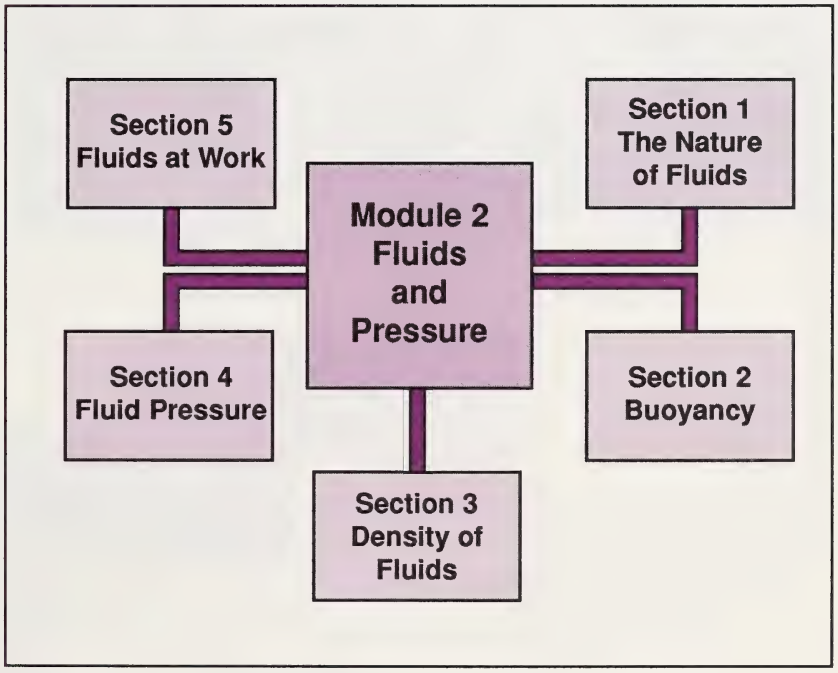
OVERVIEW

In this module you will be learning about a group of materials called fluids. Did you know that riding a bike, irrigating farmland, and drinking pop through a straw all require fluids? Fluids make an enormous number of jobs much easier.

Refer to pages 58 and 59 of your textbook for an introduction to fluids.



Evaluation

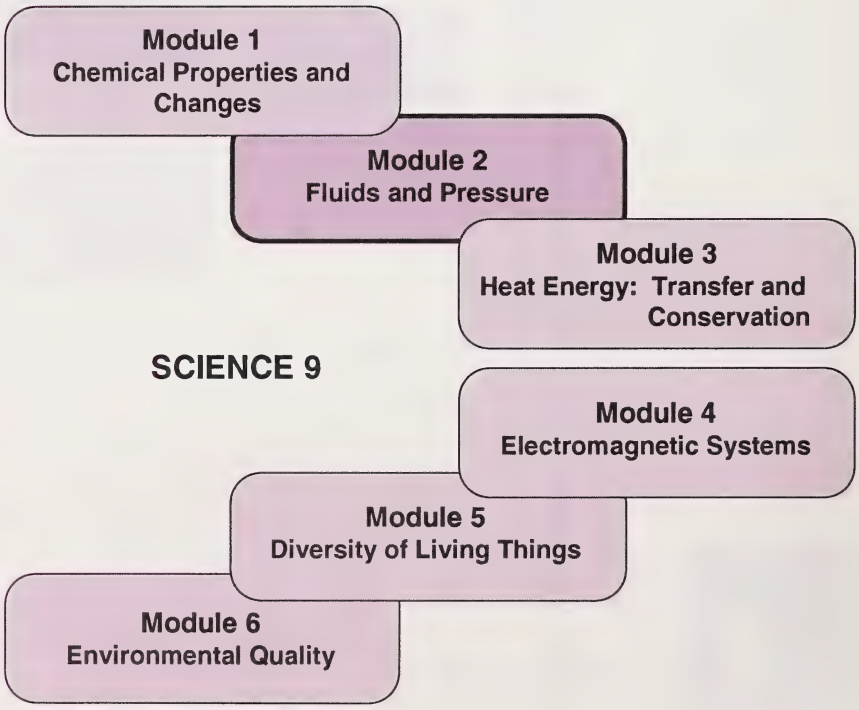
Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete five section assignments and a final module assignment.

The assignment breakdown is as follows:

Section 1 Assignment	**13%**
Section 2 Assignment	**12%**
Section 3 Assignment	**15%**
Section 4 Assignment	**20%**
Section 5 Assignment	**20%**
Final Module Assignment	**20%**
TOTAL	**100%**

Course Overview

Science 9 contains six modules. The module you will be working on is highlighted.



Section

1

The Nature of Fluids

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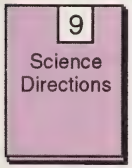
You probably already know that there are three states of matter found on Earth: solids, liquids, and gases. Have you ever noticed that there is a difference between rock (a solid), water (a liquid), and air (a gas)? Water flows. So does air, even though it is harder to see. But solid rock certainly does not flow. In recognition of this difference, gases and liquids are classified as **fluids**.

Fluid: any substance that can flow; a gas or a liquid

Read Page 60 in your textbook.

In this section you will learn that gases and liquids are fluids, that gases and liquids flow at different rates, that the rate at which fluids flow can be changed, and that movement through gases is easier than movement through liquids.



Activity 1: Fluids

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Water is visible, and so it is easy to see what it is doing. The problem with investigating most gases is that they are invisible. As a result, you have to depend on your other senses and inferences to find out about gases.

9 Science Directions

1. Study picture (a) on page 60 of your textbook. How can the three people in the photograph tell that there is flowing water behind them?

_____

_____

_____

_____

9 Science Directions

2. Study picture (b) on page 60 of your textbook. What sense does the child in the photograph use to tell him that the water is flowing?

_____

_____

_____

_____

9
Science
Directions

Investigation

Refer to Activity 2-1 on page 61 of your textbook.

3. Do step 2 of the procedure. Demonstrate to your learning facilitator that gases do flow. Describe your demonstration.

Share your answers with your learning facilitator.

4. What sense did you use to help show that gases flow? Explain your answer.

5. What does the word *flow* mean?

6. Which states of matter flow?

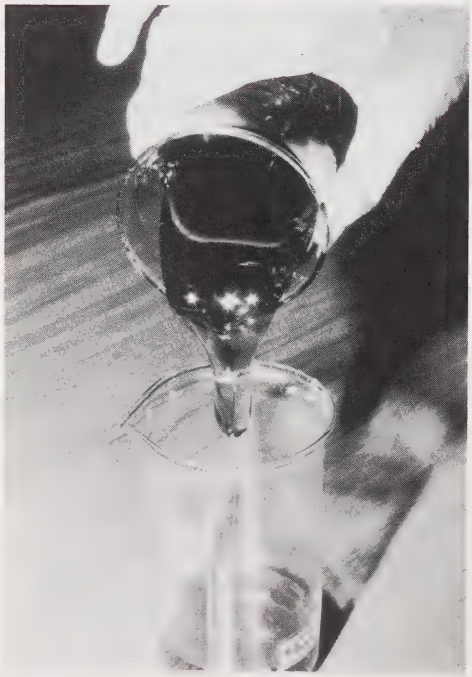
9 Science Directions

Read the bottom of page 61 and all of page 62 in your textbook for an explanation of fluids and the particle theory.

7. Use the particle theory to explain why liquids and gases flow, whereas solids do not.

Check your answers with your learning facilitator.

Activity 2: Flow Rates of Liquids and Gases



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Now that you have an idea of what fluids are, you have to find ways to describe them. As you saw in the previous activity, there are definite differences between fluids. Since fluids are substances that flow, this feature can be used as a starting point for describing fluids.

Read page 63 in your textbook to find out how syringes can be used to study the characteristics of fluids.

9 Science Directions

9
Science Directions

Investigation

Refer to Activity 2-2 on page 64 of your textbook.

You will now use a modified syringe to compare the flow rates of liquids and gases. The syringe you are using may be marked in cc, so remember that $1\,cc = 1\,cm^3 = 1\,mL$.

The problem that you are investigating can be stated this way: Is there a difference in the speed with which water and air flow?

- Collect the materials listed. If you cannot get a support stand with burette clamps, have another person hold the syringe above the beaker by hand.
- Do steps 1, 2, and 3 of the procedure outlined in the textbook. Be sure to accurately fill the syringe with the exact amount of fluid required. You may balance a book (your textbook or one that has about the same mass) on the platform to serve as the 1 kg mass. Measure the time that it takes for the air to flow through the syringe. Record the time in the table that appears in question 1. Repeat this process two more times.
- Practise filling the syringe with 50 mL of water (as illustrated in your textbook).
- Measure the time that it takes for the water to flow out of the syringe as you did for air. Record the time in the table that appears in question 1. Repeat this process two more times.

1. Complete the table with the times needed to empty the syringe.

Fluid	Trial	Time (s)
Air	1	
	2	
	3	
Water	1	
	2	
	3	

2. Answer the first part of question 1 of Analysis on page 65.

Check your answers by turning to the Appendix, Section 1: Activity 2.

The fact that water and air have different flow rates makes one easier to move through than the other.

Activity 3: Moving Through Air and Water

WESTFILE INC.

As you have discovered, some fluids flow at different rates than others.

Read page 65 in your textbook and then answer the following questions.

1. What everyday examples can you think of that also illustrate the fact that a gas is easier to move through than a liquid?

2. There is a practical example described at the top of page 65 of your textbook. What is it and how does it make use of the information that you discovered in the previous activity?

_____

_____

_____

_____

_____

_____

3. The word used to describe how fast or slow a fluid flows is _____.

4. Make up a sentence that includes the word from question 3 and the names of two fluids. Make sure that the sentence illustrates how well you think the substances will flow when compared to each other.

_____

_____

_____

Compare the two vans in the pictures. The new van has been designed to travel through air easily. This makes the new van more fuel efficient than the old van.

5. How has the front of the new van been changed to allow the van to travel more easily through air?

_____

_____

_____

You have become aware that the shape of an object is important to the ease with which it passes through a medium. The front should be shaped so that the medium will be separated gradually. The shape of the back of an object is also important. The back must be shaped to allow the medium to come back together gradually as the object moves through the medium. That is why experimental solar-powered vehicles have a long tail that comes to a point. These vehicles have limited power, so designers try to reduce air resistance as much as possible.

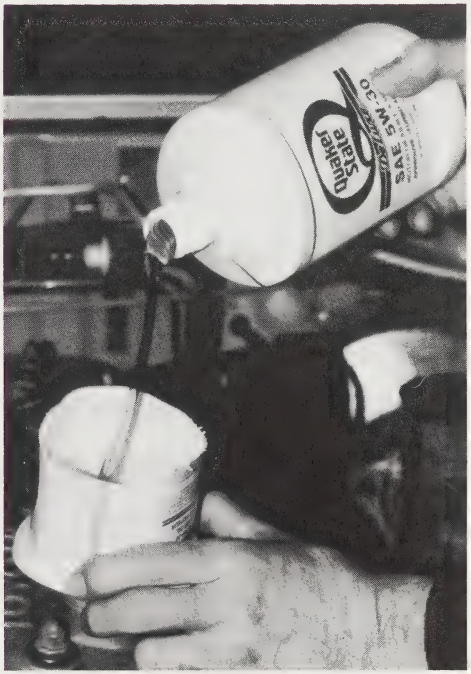
Streamlined: shaped to reduce resistance to motion through a fluid

An object is **streamlined** if it is shaped so that it can move through a fluid with the least possible resistance. Besides having a properly shaped front and back, an object must have a smooth surface with no sharp corners in order to be streamlined. A rough irregular surface causes the fluid to form swirls or eddies as the object moves through it. Turbulence is the formation of swirls and eddies around a moving object. Turbulence increases the resistance to motion.

6. A sounder is a weight that is attached to a line and used to measure the depth of water. Design a sounder that will drop through water very easily. Sketch a picture of your design. Label the sketch to indicate how you would make it streamlined.

Check your answers by turning to the Appendix, Section 1: Activity 3.

Activity 4: Flow Rates of Different Liquids



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Viscosity: a measure of how easily a fluid flows; resistance to flow

You have learned that gases and liquids have different **viscosities**. In the next investigation you will compare the viscosities of different liquids found around the home.

Investigation

Refer to Activity 2-3 on pages 66 and 67 of your textbook.

1. What is the problem?

_____

_____

- Collect the materials listed. You may also use unused engine oil, milk, plain stirred yogurt, syrup, or other liquids approved by your learning facilitator. Avoid using isopropanol if you are using plastic syringes. The alcohol damages the surface of the plastic and ruins the syringes.

9 Science Directions

- Be sure to handle all the liquids with care, dispose of them appropriately, and clean the syringe thoroughly after each liquid. Keep the glycerol and vegetable oil that you use. These will be used again.

- You may balance one or two suitable hardcover books on the syringe platform to serve as a 2 kg mass. You can use a spring scale to select the books. Together the books should weigh about 20 N on a spring scale.

- If you cannot get a support stand with burette clamps, have another person hold the syringe above the beaker by hand.

- If you have no one else to share data with, you will be testing all four liquids yourself. Do step 2 of the procedure outlined in the textbook and record your data for each of the four liquids. Record your data in the chart that appears in question 2.

2. Fill in the first and third columns in the table.

Liquid	Volume (mL)	Time (s)
water	50	
	50	
	50	
	50	

The rate of flow measures how many millilitres of liquid flow out of the syringe per second. To determine the rate of flow of the liquids, you divide the volume by the time. See step 2 of Analysis for more detail.

Suppose the time for a certain liquid to flow out of the syringe was 10 s. The flow rate can be calculated as follows:

$$\text{flow rate} = \frac{\text{volume of liquid (mL)}}{\text{time (s)}}$$

$$= \frac{50\ \text{mL}}{10\ \text{s}}$$

$$= 5\ \text{mL/s}$$

3. In the space provided, calculate the flow rate for each of the four liquids that you tested.

4. Enter the flow rates that you calculated in the following table.

Liquid	Volume (mL)	Flow Rate (mL/s)
water	50	
	50	
	50	
	50	

5. In the following table, enter the substances in order from most viscous (most time to flow) to least viscous (least time to flow). Include your calculated flow rates.

Liquid	Flow Rate
water	mL/s
	mL/s
	mL/s
	mL/s

9 Science Directions

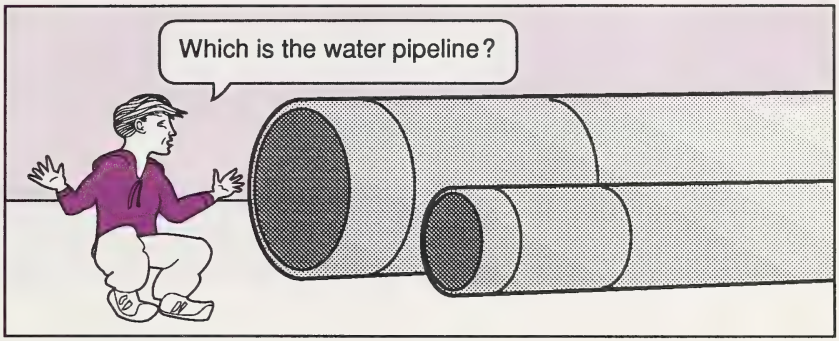
6. Answer questions 6. (a) and (b) of Further Analysis on page 67.

Textbook question 6. (a):

Textbook question 6. (b):

7. When different liquids are to be moved through tubes and pipes, the viscosity of the liquids has to be considered in order to determine the size of tubes to be used. With this in mind, why are milk shake straws different from soft drink straws?

Suppose that you see two pipelines near a city. You notice that one pipeline is larger than the other. You know that one carries water and one carries oil.



8. If you assume that both pipelines carry the same amount of liquid, which one is the water pipeline, the larger one or the smaller one? Use what you have learned in this activity to explain your answer.

Check your answers with your learning facilitator.

Activity 5: Changing the Viscosity of a Liquid

You have learned that different liquids have different viscosities because of the forces of attraction between the particles of the substance. Strong attractive forces mean high viscosity and low attractive forces mean low viscosity.

Can the viscosity of a liquid be changed? Is there a way that you can change the attractive forces between the particles in a liquid?

9
Science Directions

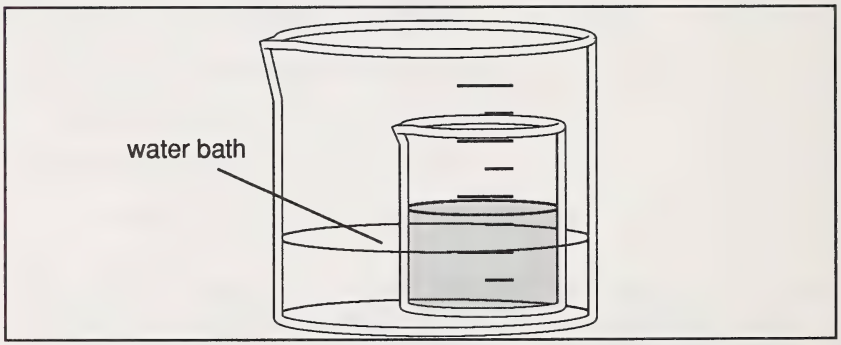
Investigation

Refer to Activity 2-4 on page 68 of your textbook.

1. What is the problem?

Caution: Observe the safe handling of the hot water and oil. Hot oil may spatter.

Collect the materials listed. Note that only one 250 mL beaker and one large container for a water bath is needed. Water baths are larger containers of water that are used to heat or cool a smaller container placed inside.



Corn syrup may be used in place of vegetable oil. As in previous activities, you may have another person holding the syringe, rather than using a support stand and clamps. Books may be used for the masses. Any container can be used to catch the liquid that is ejected out of the syringe – why not use the beaker that originally contained the sample?

Do steps 1, 2, 4, 5, and 6 of the procedure. Do not do step 3. As you collect the data, do question 2. If you have only one 250 mL beaker, or one large container for a water bath, you may prepare the samples of oil at different temperatures one after the other, rather than all at the same time.

2. Fill in the following table with your data.

Flow Rate and Temperature

Temperature (°C)	Volume (mL)	Time (s)	Flow Rate (mL/s)
	50		
	50		
	50		
	50		

3. What is the effect of different temperatures on the viscosity of vegetable oil?

Keep the vegetable oil for activities that follow. If you used corn syrup, ask your learning facilitator what to do with it. Remember to wash the syringes and equipment that you used.

4. Use the particle theory to explain your results. (Remember what happens to particles when they are heated.)

Read page 70 in the textbook and then answer the next question.

5. In your own words, why is it important that the viscosity of liquids at different temperatures be known in Alberta?

_____

_____

_____

_____

_____

_____

_____

Check your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Fill in the blanks with the words from the list. Use each word only once.

quickly	decreases
fluids	liquids
temperature	flow
viscosity	gases
slower	low
high	

In this section you have been examining the types of matter called _____. They are substances that _____, as water does in a river or through a hose. Fluids include both _____ and _____.

Gases flow more _____ than liquids. For example, the flow of water is _____ than the flow of air.

The speed that fluids flow at is called their _____;

_____ viscosity means that the fluid flows slowly,

_____ viscosity means that the fluid flows quickly.

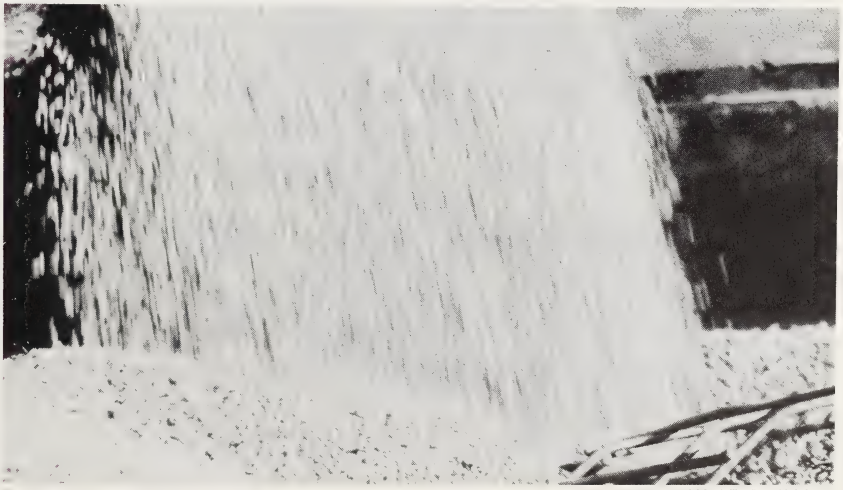
Finally you found that _____ has an effect on the viscosity of a liquid. As it is heated up, the viscosity _____. Keep in mind that you are not referring to the melting or freezing of a substance.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

When a truck that is full of grain or sand is dumped, doesn't it look like the grain or sand is flowing?

Are these substances fluids?



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Refer to the bottom of page 61 in the textbook. Then answer question 1.

1. Explain in your own words why sand is not a fluid.

2. Use the particle theory to explain why gases flow more freely than liquids.

3. Sometimes it takes a long time to get syrup out of a bottle that is almost empty. Use what you learned in this section to explain how you could get syrup out of the bottle quickly.

4. Classify the following substances as fluids or non-fluids. Give reasons for your answers.

   a. silicon putty

b. a rubber ball

c. butter on a hot day

d. gelatin (jelly) in the refrigerator

Share your answers with your learning facilitator.

Conclusion

In this section you have been introduced to the idea of fluids and some of their properties. From the activities, you have seen that gases and liquids are fluids and that the rate at which fluids flow is called viscosity. Through experiments you discovered that different fluids have different viscosities and that the viscosity of liquids can be changed by heating.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Section

2

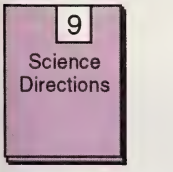
Buoyancy

Why do some things float in water, but others do not? How can a ship that weighs many tonnes float in water? Why does wood that has been in the water for a while sink? What allows blimps to float in the air? In this section you will start to answer some of these questions by studying **buoyant forces**.

Buoyant force: the upward force of a fluid on another object or material

Read page 72 in your textbook.

In this section you will learn that some gases can float on other gases. You will also learn that the buoyant force is different for different liquids, and that liquids can exert a buoyant force on other liquids.



Activity 1: Floating One Gas on Another Gas

Suppose your propane stove had a small leak. Why could a dog in the same room detect the leaking gas before you could? The next investigation deals with a characteristic of gases that relates to this question.

9
Science Directions

Displace: to push aside or out of a position

Investigation

Refer to Activity 2-5 on page 73 of your textbook.

Is one gas able to **displace** another? This is the problem that you are going to investigate.

Collect the materials that are needed for this investigation. If you do not have baking soda and vinegar, you may use a can of soft drink instead. A large measuring cup may be used in place of a 600 mL beaker.

Caution: Handle the matches or burning wooden splint and the candle with care. A pair of pliers may be used to safely light the candle with the match or burning splint.

If you are using vinegar and baking soda, carefully follow steps 1, 2, and 3 of the procedure outlined in the textbook. If you are using the soft drink, follow the steps listed on the next page.

- Place the candle in the bottom of the 250 mL beaker. Light the candle and allow it to attain a stable flame.
- Pour about 150 mL of the soft drink into the 600 mL beaker or into a measuring cup. Make sure that the soft drink fizzes vigorously.
- After the bubbles have disappeared, place the cardboard over the beaker.
- As illustrated in your textbook, carefully pour the gas down the side of the 250 mL beaker, but do not pour any of the soft drink out of the 600 mL beaker.

1. Describe what happened to the flame when the gas was poured on it.

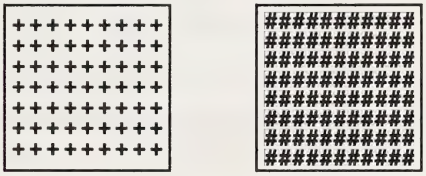
_____

_____

_____

Check your answer with your learning facilitator.

2. When baking soda and vinegar are mixed, or when a soft drink is poured, carbon dioxide is produced. Draw a diagram that shows what you think happened to the air and carbon dioxide during this investigation. Use the designs indicated in the legend to show the air and the carbon dioxide in "before and after" diagrams.



3. Use the words *float* and *displace* to describe what happened to the air and the carbon dioxide.

Check your answers with your learning facilitator.

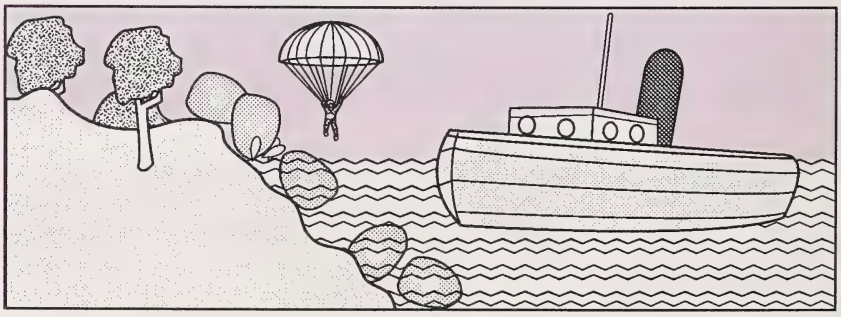
Now you should be able to answer the question that was asked at the beginning of this activity.

Just like carbon dioxide, propane can displace air – air floats on top of propane. So when propane leaks from a stove, it falls towards the floor, where it accumulates. Since the dog's nose is closer to the ground and is more sensitive than your nose, the dog will likely smell the propane before you do.

Activity 2: Buoyant Forces of Various Liquids

Buoyancy: the tendency of an object or material to float in a fluid

When you speak of **buoyancy**, you generally think of something floating in water, since it is the liquid that you are most familiar with. As you already know, gases are also fluids. In order to fully understand the forces of buoyancy, you need to think of gases as being similar to water. Air is a fluid since it can be poured and it exerts buoyant forces just like water. It may be helpful to think of Earth's atmosphere as being an ocean of air where people and most objects sink to the bottom.



9 Science Directions

9 Science Directions

Read Buoyant Force on page 74 of your textbook.

Investigation

Refer to Activity 2-6 on page 74 of your textbook.

Problem

Is there a buoyant force on a solid in a liquid?

Materials

- one large pail
- one ice-cream bucket or similar container
- water
- sand or soil

Procedure

9 Science Directions

Refer to the photographs on page 74 of your textbook.

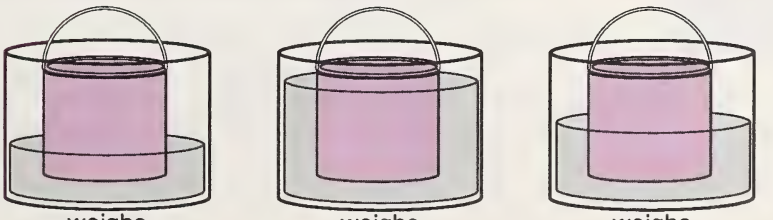
- Fill the ice-cream bucket with sand or soil.
- Fill the pail about half full of water.
- Slowly lower the sand-filled bucket into the pail. Do not let the bucket sink completely into the water, or else the water in the pail will overflow. Note how the weight of the sand-filled bucket appears to change.

1. What happened to the weight of the sand-filled bucket as you lowered it into the water?

_____

_____

2. Describe the weight of the sand-filled bucket in the three positions illustrated. Indicate in which position the bucket weighs the most, the least, and in between.



_____ _____ _____

3. Make a rule about buoyant forces by filling in the blanks with the following words:

displaces buoyant volume

The greater the _____ of fluid that an object

_____, the greater the _____ force will be.

4. What do you think caused the sand-filled bucket to weigh less when it was in the water? Use the words *buoyant force*, *displaced*, and *exerted* in your answer.

_____

_____

_____

_____

_____

_____

Check your answers with your learning facilitator.

To study the buoyant forces of different liquids, you will now do an investigation where you will measure the actual force at work.

Investigation

Refer to Activity 2-7 on page 75 of your textbook.

Do different liquids exert different buoyant forces? This is the problem for this investigation.

- Collect the materials that are needed. A measuring cup may be used in place of a 600 mL beaker. Only one such container is needed if you empty and clean it after each dunking. A stone or a plastic bag of sand may be used for the 500 g mass.

- Perform steps 1 to 3 and steps 5 to 7 of the procedure. Do not do step 4.
- Measure the apparent weights of the 500 g mass using a spring scale. Record the weights in the table that appears in question 6.

5. The weight of the 500 g mass in air is _____ N.

6. Complete the table.

Liquid	Weight in Liquid (N)
water	
vegetable oil	
glycerol	

7. What happened to the weight of the 500 g mass when it was submerged into the three liquids?

_____

_____

_____

_____

_____

_____

_____

Read question 4 of Analysis on page 75 of your textbook.

The formula for calculating the buoyant force is as follows:

weight in air – weight in liquid = buoyant force

For example, if an object weighed 6.1 N in air and 4.7 N in a liquid, then the buoyant force is 1.4 N.

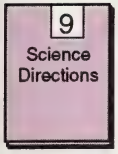
8. Calculate the buoyant force for each of the three liquids.

9. Complete the table.

Liquid	Buoyant Force (N)

Check your answers with your learning facilitator.

You have found that the magnitude of the buoyant force depends on the fluid involved. There is a relationship between how liquids float on each other and how much buoyant force they exert. You will discover this relationship in the next activity.



Activity 3: Liquids Floating on Liquids

In the previous activities you learned that gases can exert a buoyant force on other gases, and that liquids can exert a buoyant force on a solid. Do liquids exert buoyant forces on each other?

Investigation

Refer to Activity 2-8 on page 77 of your textbook.

The problem can be stated as follows: Do liquids exert buoyant forces on other liquids?

You will make a prediction in the next question.

1. Which liquid do you think will sink to the bottom when all three liquids are mixed in a test tube? Use the buoyant forces exerted by the three liquids in the previous activity as a guide.

   a. The top liquid is _____.

   b. The middle liquid is _____.

   c. The bottom liquid is _____.

- Collect the materials that you will need for this investigation.
- Do steps 2 and 3 of the procedure.

2. Draw and label the layers of liquids as they appear in the test tube.

Refer to the buoyant forces exerted by the liquids in the previous activity. Compare the order of the buoyant forces from the previous activity with the order of the layers in which the liquids settled in the test tube.

3. Fill in the table with the names of the liquids used.

Liquid According to Position in the Test Tube	
Top	
Middle	
Bottom	

Liquid According to Buoyant Force	
Least	
Middle	
Greatest	

4. Which liquid exerted the greatest buoyant force in this investigation? Explain your answer.

• Dispose of the combined liquids down the drain.

Read Heavier? Lighter? on page 77 of your textbook.

5. You have completed three activities that dealt with the buoyant forces of fluids. In your own words, what does *buoyancy* mean?

6. Based on the investigations in this section, indicate whether the following statements are true or false by writing **T** or **F** behind each statement.

   a. One gas can displace another gas. _____

   b. The buoyancy of a liquid on a solid depends on the volume of the liquid displaced by the solid. _____

   c. The buoyant force on an object depends on the type of liquid used. _____

   d. One liquid can displace another liquid. _____

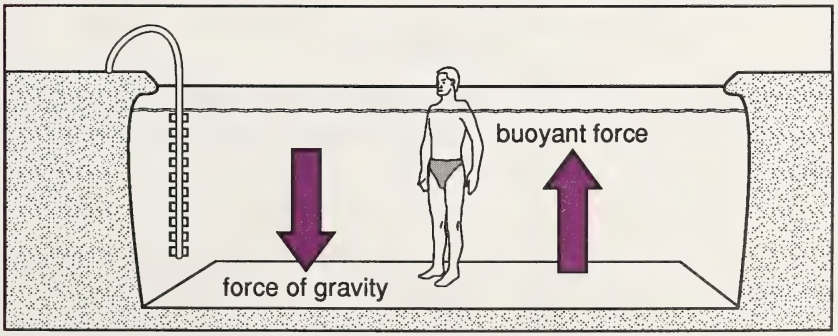
Check your answers by turning to the Appendix, Section 2: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

If you have ever gone for a swim in a pool or in a lake, you know that you feel lighter in the water than out of the water. Remember that your weight is actually the force of gravity acting on you. If you seem to weigh less in the water, is it because the force of gravity is less? There is no evidence that this is true. Therefore, it must be because there is another force at work that is acting upwards, or against the force of gravity. This is the force of buoyancy. It is the force that you studied in this section.



Fill in the following description of this section's activities using the words from the word list. Each word is used once.

liquids	weight	gas
appear	upward	smallest
top	loss	bottom
force	newtons	buoyant
displace		

In the first activity you learned that one _____ can push aside, or _____, another. The carbon dioxide exerted a _____ force on the air and pushed it up and out of the way.

In the second activity you showed that objects put into water _____ to lose _____. The apparent _____ in weight is called the buoyant _____ exerted on that object. Buoyant force is measured in _____ and is always an _____ force.

In the third activity you learned that liquids can exert a buoyant force on other _____. The liquid that exerted the greatest buoyant force is at the _____ of the test tube. The liquid that exerted the _____ buoyant force is at the _____ of the test tube.

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

1. You have learned that fluids exert a buoyant force on objects in them. How could you measure the buoyant force of the air on an object?

_____

_____

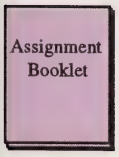
_____

2. You weigh less in water than in air because water applies a greater buoyant force than air. If you were able to weigh yourself in helium, would you weigh more or less than in air? Explain your answer.

Share your answers with your learning facilitator.

Conclusion

Buoyant force is the upward force exerted by a fluid on an object or substance in it. Both gases and liquids exert this force on other gases, liquids, and solids. Different fluids exert different buoyant forces.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

Section

3

Density of Fluids

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You may have stood next to a lake and seen canoeists paddle across the surface of the water. Yet, if you threw in a rock, it would just sink to the bottom. What is the reason for buoyancy?

Read page 78 in your textbook *Science Directions 9*.

In this section you will learn why things float and sink, what the meaning of **density** is and what its relationship to buoyancy is, how to make an instrument that can measure density, and the relationship between the temperature and the buoyancy of a fluid.

9
Science Directions

Density: the mass in a certain volume of an object or material

Activity 1: Why Things Float

Why does oil float on water? Why does a rock sink and a log float? What property determines the floating behaviour of an object? In this activity you will determine the nature of this property.

Do either Part A or Part B.

Do Part A if you have a balance for measuring mass. Otherwise, do Part B.

Part A

Investigation

9 Science Directions

Refer to Activity 2-9 on page 79 of your textbook.

1. What is the problem?

_____

_____

Collect the materials listed. Do steps 2 to 7 in the procedure. Accuracy is important in these steps.

2. Fill in the first two columns of the table.

Mass of Different Liquids – Same Volume				
Liquid	**Mass of Graduated Cylinder (g)**	**Mass of Graduated Cylinder + Liquid (g)**	**Mass of 50 mL of Liquid (g)**	**Mass of 1 mL of Liquid (g)**
glycerol				
vegetable oil				
water				

3. Do steps 1. (a) and 1. (b) in Analysis on your own paper and fill in the last two columns of the table that appears in question 2.

Remember to keep the glycerol and vegetable oil.

End of Part A

Part B

Investigation

Refer to Activity 2-9 on page 79 of your textbook.

4. What is the problem?

_____

_____

In this investigation you will be given data which you will analyse to determine why things float.

Read steps 2 to 7 in the procedure on page 79 of your textbook. Then study the data in the following table.

Mass of Different Liquids – Same Volume

Liquid	Mass of Graduated Cylinder (g)	Mass of Graduated Cylinder + Liquid (g)	Mass of 50 mL of Liquid (g)	Mass of 1 mL of Liquid (g)
glycerol	78	141		
vegetable oil	78	123		
water	78	128		

5. Do steps 1. (a) and 1. (b) from Analysis on your own paper and fill in the last two columns of the table on the preceding page.

End of Part B

You will now follow some steps that will use your data to help determine what causes things to float or sink.

In a previous activity you compared the buoyant forces of glycerol, vegetable oil, and water by lowering a 500 g mass into each of the liquids.

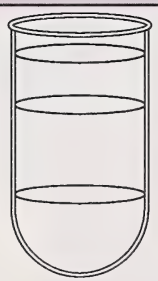
6. In the first column of the table that follows question 8, list the liquids according to their buoyant forces on the solid. List them in order from least to greatest force.

In another activity you poured glycerol, vegetable oil, and water into a test tube. These liquids formed into layers.

7. In the middle column of the table that follows question 8, label the liquids in the container in the order that you found them in the activity. Write the names of the liquids right on their positions in the container.

8. Complete the third column of the table using the data from this investigation. List the liquids in order from least to greatest mass per millilitre (density).

Comparing Buoyant Force and Mass

	Buoyant Force on Solid	Buoyant Force on Liquid	Mass of 1mL of Liquid (g)	
least				least
most				most

9. By comparing the buoyant forces and the masses of a certain volume of the three liquids in the preceding chart, can you suggest a way that you can predict whether something will sink or float in a fluid?

Check your answers with your learning facilitator.

Activity 2: Fluid Density and Buoyancy

In the previous activity you determined a very important property of all substances – density. Density is more than just the mass of an object.

Read The Meaning of Density on pages 80 and 81 of your textbook.

1. What are the two measurements you have to make to determine the density of a substance?

2. By using the example of feathers and gold on the page that you just read, state what density means.

3. Which of the fluids listed in Table 2-5 will exert the greatest buoyant force on a solid that is submerged in it?

4. Which of the fluids listed in Table 2-5 will exert the least buoyant force on a solid that is submerged in it?

9 Science Directions

5. Answer questions 2. (a) and 2. (b) in Activity 2-10 on page 81 of your textbook.

   Textbook question 2. (a):

   Textbook question 2. (b):

9 Science Directions

6. Answer questions 3. (a) and 3. (b) in Activity 2-10 on page 81 of your textbook.

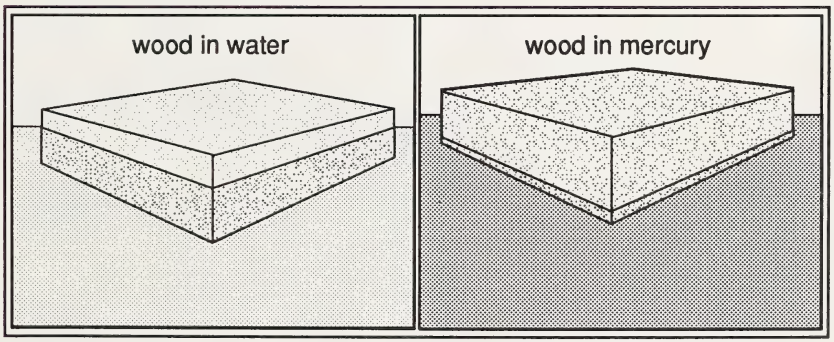
   Textbook question 3. (a):

   Textbook question 3. (b):

7. Explain in your own words why ships made of steel can float.

Check your answers with your learning facilitator.

Activity 3: Measuring Density with Hydrometers



The previous activity showed you the importance of density in fluids. But can you determine the density of a fluid quickly and accurately? In this activity you will make a **hydrometer**, an instrument that can determine densities. A hydrometer relies on the buoyant force that a liquid exerts on it. Liquids of different densities exert different buoyant forces on the hydrometer, causing it to float higher or lower in the liquid.

Hydrometer: a floating device used to measure the density of fluids

Read page 82 of your textbook.

9
Science Directions

Investigation

Refer to Activity 2-11 on page 83 of your textbook.

1. What is the problem?

_____

_____

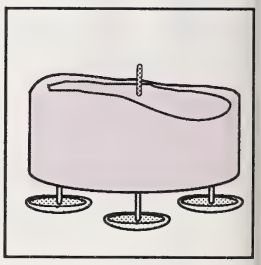
- Collect the materials necessary for Part A of Activity 2-11. Glass cups may be used in place of beakers. If you are unable to obtain these materials, the following items can be used to make hydrometers: a candle, thumbtacks, a drinking straw, modelling clay, sand, and sugar.

- Make two of the following four types of hydrometers.

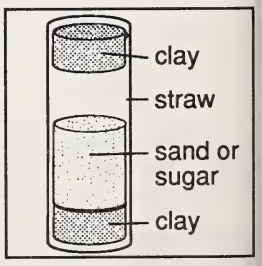
  Type A – Screw a short wood screw into one end of the wooden dowel. See the diagram in step 1 of the procedure.

  Type B – Partly fill the small plastic cream container with sand. Make sure it floats in water about half way up its side. See the diagram in step 1 of the procedure.

  Type C – Take a small candle and place some thumbtacks in the bottom. Make sure that it floats up to its midpoint in water.



  Type D – Plug one end of a drinking straw with modelling clay. Pour fine sand in the other end until the straw floats so that less than half is above the surface of the water. Plug the top of the straw with clay.



2. Do step 2 from Part A of Activity 2-11 and answer the questions that follow.

   Textbook question 2. (a):

   _____

   _____

   _____

   Textbook question 2. (b):

   _____

   _____

   _____

   Textbook question 2. (c):

   _____

   _____

   _____

   Textbook question 2. (d):

   _____

   _____

   _____

   Textbook question 2. (e):

   _____

   _____

   _____

- Do step 3 from Part A and make the appropriate marks on your hydrometers.

  For each liquid that you float your hydrometer in, carefully note the level that it sinks to and then make a mark on its side. This mark will represent the density of that liquid.

3. Make an accurate labelled sketch of your best hydrometer. Explain why you chose it as your best.

_____

_____

_____

_____

- Fill one of the beakers with water and mark the water level on your hydrometer. Add ten 5 mL spoonfuls (or ten teaspoons) of sugar to the water and stir until it is dissolved.

4. Predict whether the hydrometer will float higher or lower in the sugar solution than it would in pure water.

_____

5. Record your observations.

_____

_____

6. You can make the following inference based on your observation: The

_____ of the sugar solution increases as the

_____ of the solution increases.

Share your answers with your learning facilitator.

Activity 4: Temperature and Density of Fluids

Have you ever wondered how a hot-air balloon stays in the air? In this activity you will learn about the effect that temperature has on the density of fluids.

Read page 85 of your textbook.

1. What is the usual effect that heating has on the volume and density of an object?

2. Explain in your own words how a hot-air balloon floats in the air. Use diagrams to help explain your answer.

Check your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Fill in the blanks with the expression provided. Each expression is to be used just once.

gold	density	measure
liquid	lower	higher
volume	liquid metal	low
hydrometer	buoyant	19.32 g/mL
19 mL	mass	high
less	13.55 g/mL	

Density is the comparison of an object's _____ with its _____. For example, feathers have a _____ density and lead has a high _____. Things float in water if they have a density of _____ than 1 g/mL. Mercury is a very dense _____. It exerts a very strong _____ force on an object. One of the few materials that will sink in mercury is _____. This is because the density of gold is _____, compared to _____ for mercury. A _____ is an instrument that is used to _____ the density of a _____. It floats _____ in dense liquids and _____ in less dense liquids. Ice floats on water because its density is less than _____.

Check your answers by turning to the Appendix, Section 3: Extra Help.

9
Science Directions

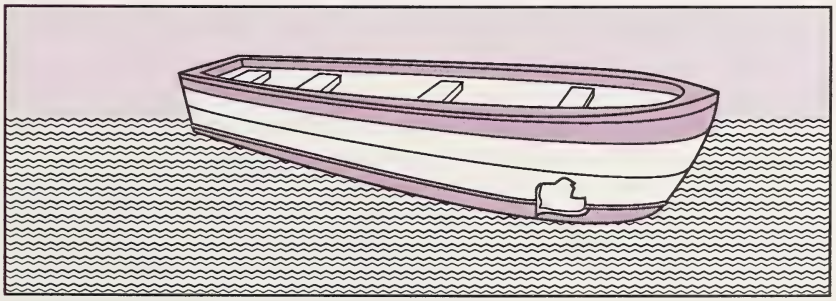
Enrichment

1. Answer question 5 in Activity 2-10 on page 81 of your textbook. Use the table on page 80 to help you determine the type of metal that the block is made of.

2. A metal ship floats because the average density of the steel, the cargo, and the air in the ship is less than the density of the water it is floating in.

   a. Why does a ship sink if it starts to leak?

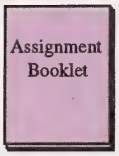
   b. How would you raise a ship that has sunk?



Share your answers with your learning facilitator.

Conclusion

In this section you have learned that the force of buoyancy is the result of the density of the fluid around an object or substance. Things float in a fluid when their density is less than that of the fluid they are floating in; they sink when their density is greater than that of the fluid they are floating in. To measure the density of fluids, you use a hydrometer. A hydrometer floats at different heights in fluids that have different densities. Heat causes fluids, like air, to expand. This results in the density of the fluid decreasing, making it more buoyant.



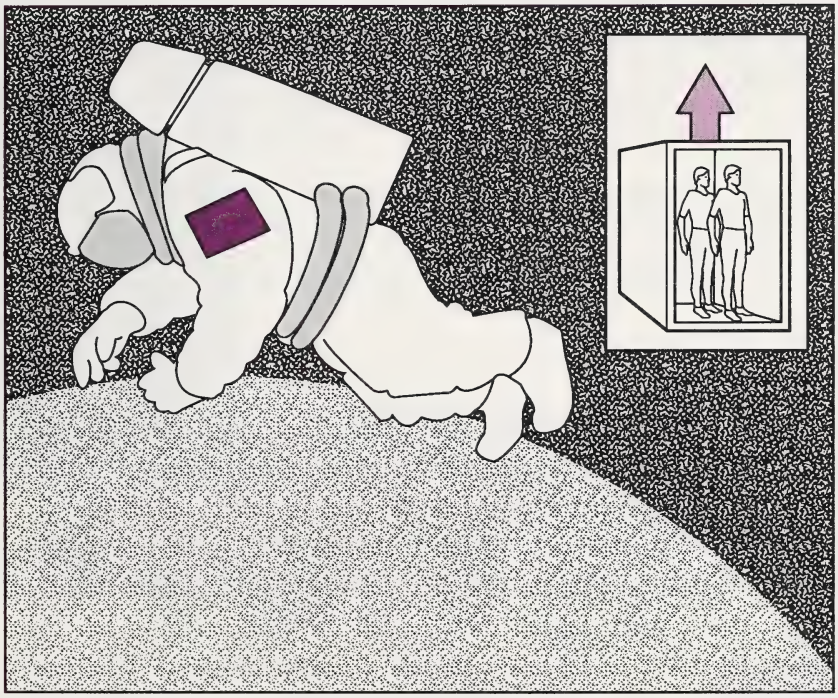
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

Section

4

Fluid Pressure



Have you ever wondered why astronauts and deep-sea divers need special suits when they are floating high above the atmosphere or deep under water? Why do your ears pop when you are in an airplane or in a fast elevator? The reason for these phenomena is pressure. You are surrounded by pressure all your life. In fact, if the pressure of the atmosphere disappeared, you would not be able to live. As you discovered in the last section, fluids can exert buoyant forces and they have different densities. You will learn that fluids can exert pressure entirely due to their mass. You will also learn what happens when forces are applied to fluids. You will study some of the properties of pressure in liquids and learn how you live with water pressure and air pressure. You will also investigate instruments that measure air pressure.

Activity 1: Forces Applied to Fluids

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You have undoubtedly used a device that applies pressure to a fluid. Any spray can, water hose, or water pistol applies pressure to a fluid. Even your lungs apply pressure to a fluid – the air.

9 Science Directions

Read pages 87 and 88 in *Science Directions 9* to find out more about how fluids behave under pressure.

1. What does *pressure* mean?

_____

_____

_____

Investigation

9 Science Directions

Refer to Activity 2-13 on pages 88 and 89 of your textbook.

2. What is the problem?

_____

_____

_____

Caution: Be careful using the masses on the syringe. Keep them well balanced to prevent damage to yourself or the syringe.

- Collect the materials listed. If you cannot obtain a support stand with clamps, get a partner to hold the syringe in place. As before, you may balance suitable books on the syringe to serve as loads. The books you select should each weigh between 10 N and 15 N.

- Do steps 2 to 6 of the procedure. If you are using books, weigh them. Record the weights of one, two, three, and four books in the second column of the table that appears in question 3. Later, use the books in the same combinations as when you weighed them. Do question 3 as you follow the procedure.

3. Complete the table.

Compressibility of Air and Water			
Mass on Piston (kg or books)	Force on Confined Fluid (n)	Volume of Air (mL)	Volume of Water (mL)
0	0	50	50
1			
2			
3			
4			
0			

4. Answer questions 1. (a) and 1. (b) from Analysis on page 89.

Textbook question 1. (a):

Textbook question 1. (b):

5. Answer questions 3. (a) and 3. (b) from Analysis.

Textbook question 3. (a):

Textbook question 3. (b):

6. Use the particle theory to explain your observations.

Observe that as the force increased, an additional 10 N of force had less effect; the first 10 N caused the greatest change in volume and the final 10 N caused the least change.

You will now look at some of the applications of the compressibility of fluids. Read pages 90 and 91 of your textbook for information about these applications.

7. Fill in the blanks with the correct word.

   Gases are _____ (incompressible, compressible) fluids and

   liquids are _____ (incompressible, compressible) fluids.

8. Where around your house is it important to use a compressible gas? Why must it be compressible?

_____

_____

_____

_____

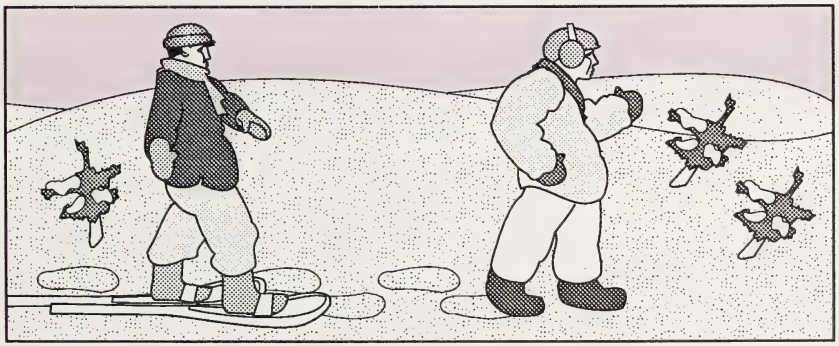
_____

_____

Check your answers with your learning facilitator.

Activity 2: Calculating Pressure in Fluids

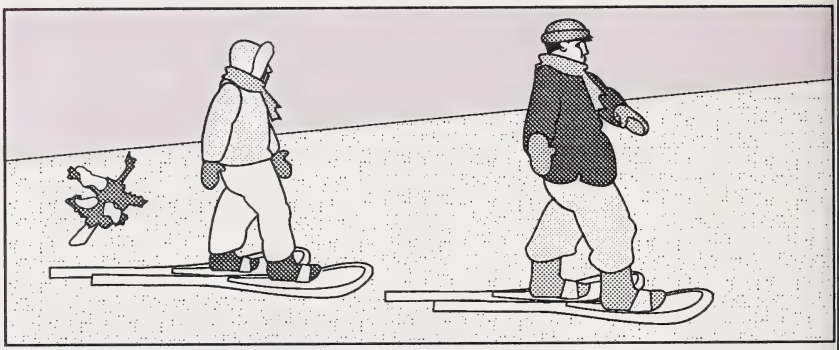
In this activity you will be learning how to predict the pressure being applied in certain situations. For example, who do you think would sink deeper into the snow, a person without snowshoes or a person with snowshoes? Assume that they both weigh the same.



Who will sink deeper into the snow?

The person without snowshoes will sink deeper because a greater pressure is being applied. This introduces one of the important factors that determines the pressure in a situation – area. The snowshoes have a large area, as compared to the area of the other person's foot. This allows the person wearing the snowshoe to travel relatively easily over the snow. Travelling in the snow without snowshoes is difficult because you sink deep into the snow.

The other essential part of understanding pressure is force. If you have two snowshoers with the same size snowshoes, but one person is heavier than the other, who will sink deeper into the snow?



Who will sink deeper into the snow?

The heavier one will sink deeper because a greater pressure is being applied on the snow, as compared to the force on the same size snowshoes of the lighter person.

So, there are two important factors that determine pressure:

- the force being applied
- the area that the force is applied over

1. Explain what happens to the pressure in each of the following situations.

   a. You take off your boots and put on your skates.

b. You put on a 300 N backpack while you are out on a cross-country skiing trip.

_____

_____

_____

_____

9 Science Directions

Read Units for Measuring Pressure on pages 91 and 92 in *Science Directions 9* to find out more about the units of pressure. Then use what you learned to answer the following questions.

2. The basic unit of pressure is the _____. It is equal to 1 _____ /_____.

3. The more common pressure unit is the _____.

4. What is the pressure at the bottom of a cubic metre of water? Give an answer for both Pa and kPa. _____ or _____.

9 Science Directions

Read The Direction of Fluid Pressure on page 94 of your textbook.

5. In what directions do fluid pressures act?

_____

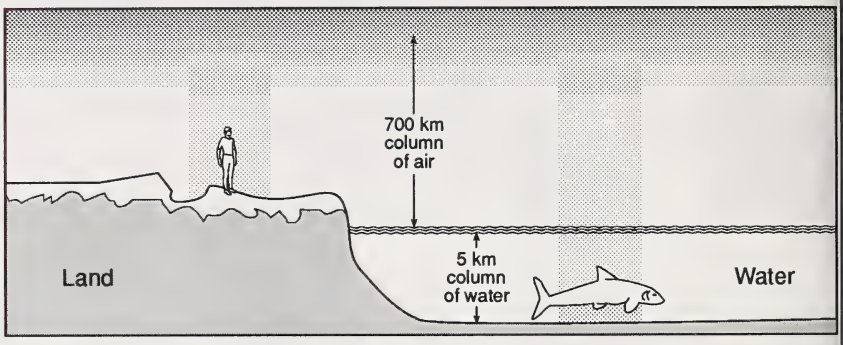
_____

_____

Check your answers by turning to the Appendix, Section 4: Activity 2.

Activity 3: Living with Air Pressure and Water Pressure

All living things live in either air or water. As a result, they have all adapted to living under various amounts of pressure. Human beings and all land animals live under the pressure of about 700 km of air. Aquatic animals live under both that pressure and the pressure of the water above them.



9
Science
Directions

Read about air pressure on pages 94 and 95 in your textbook.

1. The normal air pressure at sea level is 101.3 kPa. What does this mean in terms of gravity, force, and pressure?

2. Why does the air pressure decrease as you go up a mountain?

3. If you blow up a balloon at sea level and then travel in an car up a high mountain, what will happen to the balloon? Explain your answer.

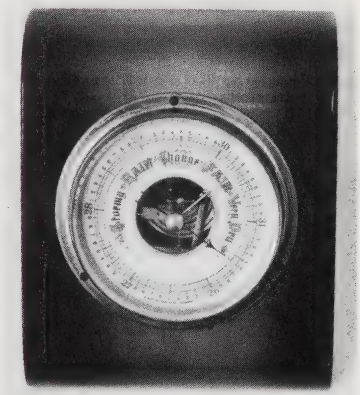
Read about water pressure on page 96 in your textbook.

4. Why is the pressure under 10 m of water so much greater than the air pressure at sea level?

5. If you inflate a balloon and take it down to 50 m under water, what will happen to it? Why?

Check your answers with your learning facilitator.

Activity 4: Devices for Measuring Pressure



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Whenever scientists find that something is measurable and changeable, an instrument to measure the quantity is developed. In this case you are going to learn how an instrument to measure air pressure, a **barometer**, works.

Barometer: an instrument used to measure air pressure

9 Science Directions

Read about barometers on pages 97 and 98 of your textbook.

1. Name the two different types of barometers and briefly describe them.

Investigation

9 Science Directions

Refer to Activity 2-15 on page 99 of *Science Directions 9.*

2. What is the problem?

- Do step 1 of the procedure. Obtain approval for your design from your learning facilitator. Then collect all the materials that you will need.
- Do steps 2 and 3 of the procedure. The longer you make the pointer, the easier it will be to make an accurate scale. In step 3 you may also use the readings that you can get from an aneroid barometer at home.

3. Do question 1 of Analysis on page 99 of your textbook.

4. Why does your barometer change with the change in air pressure?

5. Why should your barometer be kept at the same temperature for accurate readings?

6. What improvements could you make to your barometer?

Share your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Fill in the blanks below with words and expressions from the list. Use each expression or word once.

garden hoses	force	decrease	area
increase	your heart	aerosol cans	tires
do not	incompressible	submarines	pressure
all directions	less air	water pistols	gases
barometer	N/m^2	pascal	compressible

Pressure is the amount of _____ applied over a certain _____. To make a garden hose shoot the water further, you can either _____ the force or _____ the area of the opening. When pressure is applied to _____, they decrease in volume. That means that gases are _____. Liquids _____ change in volume when pressure is applied to them. They are _____. Compressible fluids are used in _____, _____, and _____. Incompressible fluids are used in _____, _____, and _____. The metric unit for pressure is the _____. It is defined as 1 _____. The direction of the force of _____ in a fluid is in _____. The air pressure decreases as you go up in the atmosphere because there is _____ above you to apply pressure. An instrument that measures air pressure is called a _____.

Check your answers by turning to the Appendix, Section 4: Extra Help.

Enrichment

1. Do question 1 in Activity 2-14 on page 93 of your textbook. Use the following table that is provided. (The space beneath the table may be used to do your calculations.)

Calculation of Pressure	Block A	Block B
Volume of water		
Mass of water		
Force of gravity (F)		
Bottom surface area		
Pressure in N/m^2		
Pressure in kPa		

There can be a wide difference in pressure exerted by the same volume or mass of water.

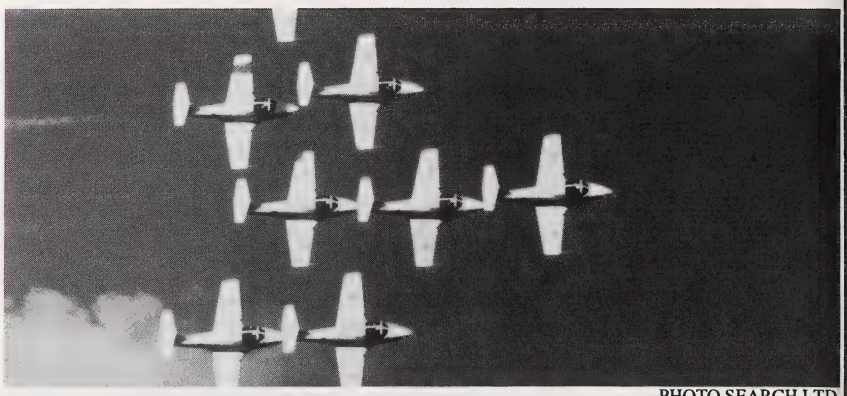
2. Regarding the direction of pressure, how is fluid pressure at the bottom of a swimming pool different from the pressure of a snowshoe on snow?

_____

_____

_____

_____



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3. Why are airplanes pressurized when they fly at high altitudes?

_____

_____

_____

_____

Share your answers with your learning facilitator.

Conclusion

In this section you have defined pressure and studied how fluids respond to pressure. Pressure is the application of a force over an area. Pressure can be increased by decreasing the area of the force or increasing the force itself.

You learned that gases are compressible fluids and liquids are incompressible fluids. This property leads to gases and liquids being used for different jobs because of their compressibility. The basic unit of pressure is the pascal (Pa). The direction of pressure in fluids is in all directions. The atmosphere applies a pressure of about 101.3 kPa on the surface of the earth. You studied and built instruments, called barometers, which measure the variations in the air pressure.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 4.

Section

5

Fluids at Work

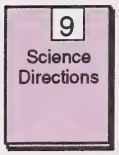
Over the past four sections in this module, you have learned some of the properties of fluids. In this section you will discover some of the uses that our society has for these substances. These include car hoists in garages, car brakes, the human heart, and water taps.

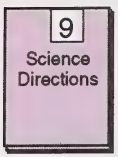
Read page 102 in your textbook for an introduction to hydraulic systems.

In this section you will learn how a hydraulic press works and discover some of its uses. You will also learn about the role of valves and pumps in hydraulic systems and the maintenance of fluid systems.

9
Science Directions

Hydraulic press: *a machine that works because of the movement of a fluid or the force of a fluid in a closed system*





Activity 1: The Hydraulic Press

The idea behind a **hydraulic press** is based on two observations that you have made previously. These observations are that liquids are incompressible and that forces can be transferred through liquids.

Read page 103 in your textbook for a description of the hydraulic press.

Investigation

Refer to Activity 2-16 on pages 104 and 105 of your textbook.

1. What is the problem for this investigation?

_____

_____

_____

_____

- Collect the necessary materials. As before, if you cannot get support stands and clamps, have a partner hold the syringes in place.
- You may use a book as a load on the syringes. You may find that a load of less than 10 N (1 kg) works better than the 1 kg mass listed.
- The tubing listed need not be rubber; vinyl tubing works well. The tubing should fit over the syringe tip.
- Do steps 1 to 9 of the procedure outlined in the textbook.
- Lubricate the syringes with vegetable oil or glycerol. Do not adjust the clamps too tightly around the syringes. The pistons must be able to move freely.

2. Use the terms *less than standard force* and *more than standard force* to fill in the third column of the table at the top of the next page.

Size of Piston		Force Required
Effort (thumb)	Load (1 kg mass)	
same area	same area	standard force
smaller area	larger area	
larger area	smaller area	

9 Science Directions

3. Do question 2 of Analysis on page 105 of your textbook.

4. Make a rule about the effort required to lift a weight and the area of the piston through which the effort is applied. Use the results from the table as a guide.

5. When you applied the effort to the small syringe, which syringe piston moved a greater distance?

You may still have some vegetable oil and glycerol left over from your investigations. Ask your learning facilitator what to do with these substances.

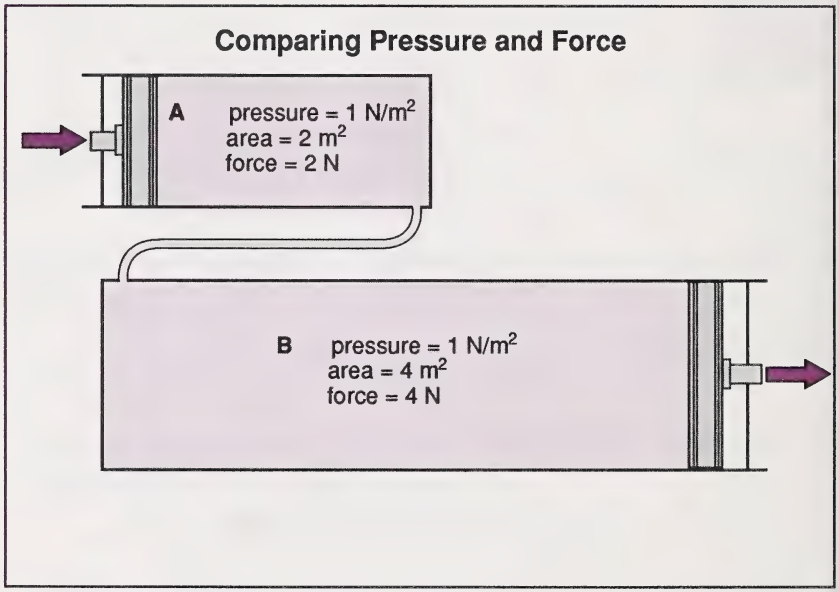
Check your answers by turning to the Appendix, Section 5: Activity 1.

Activity 2: Uses of the Hydraulic Press

You demonstrated the basic principles of a hydraulic press in the previous activity. In this activity you will see how the hydraulic press is used in everyday life.

Read pages 106 and 107 in your textbook.

The important point to remember is that the pressure inside the hydraulic system is the same throughout the system. This does not mean that the force is the same. Remember that pressure is the force over a certain area, such as a square metre. Force is the total push or pull over the area.



By doubling the area you are able to double the force output by the system. The total force on the piston in container A is 2 N, in container B it is 4 N.

1. Study the illustration on page 107 of your textbook. The drawing is not to exact scale. Based on what you know about hydraulic systems, what are some of the factors that you could change in order to reduce the force required by the driver to apply the brakes? Give your reasons.

2. If the piston in the master cylinder is smaller than the piston in the wheel cylinder, which piston will travel further in its cylinder when the brakes are applied?

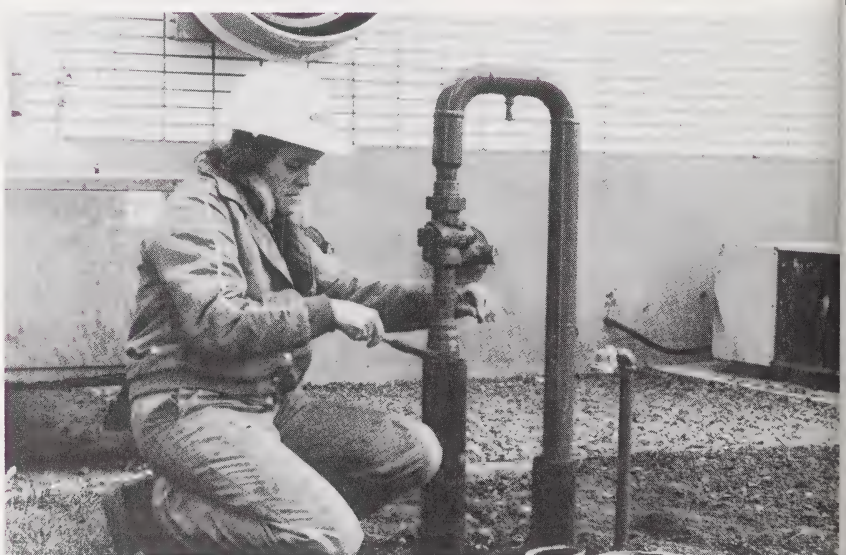
3. Fill in the blanks with the phrases *less than*, *the same as,* and *greater than.*

   A system is set up with a small piston applying a force to a large piston. The large piston moves _____ the small piston. The pressure on the large piston is _____ the pressure on the small piston. The force on the small piston is _____ the force on the large piston.

Another system is set up with a large piston applying a force to a small piston. The small piston moves _____ the large piston. The pressure on the small piston is _____ the pressure on the large piston. The force on the small piston is _____ the force on the large piston.

Check your answers with your learning facilitator.

Activity 3: Valves for Hydraulic Systems



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In a hydraulic system there are often openings where the fluid can be pumped in or out of the system. These openings must be able to be opened and closed easily and they must be leakproof. These openings that regulate the fluid flow are called **valves**.

Valve: a device that controls the size of an opening to control the flow of a fluid

9
Science Directions

Read page 109 of your textbook for an introduction to different types of valves.

1. a. Study a tire valve on your bicycle or on a car or truck. Draw a cross section (a wide view as if its cut through the middle) of the valve.

   b. What is the purpose of the tire valve?

   c. Describe how you think the valve works.

2. What is the purpose of the valves in your heart?

9 Science Directions

Investigation

Refer to Activity 2-17 on page 110 in *Science Directions 9.*

3. What is the problem?

_____

_____

- Collect the assorted materials that you will need and do either step 1 or step 2 of the procedure.

4. Make a preliminary sketch of your valve.

- Build the valve as shown in your diagram. Test your valve.

5. What changes would you make to the valve to make it a better product? Why?

_____

_____

_____

_____

_____

_____

6. a. Draw and label your improved valve in the open and closed positions. Include the direction of the flow of fluid through the valve.

b. What could the valve be used for?

_____

_____

_____

_____

7. What is the advantage of making a model of your valve early in the exercise?

_____

_____

_____

_____

Check your answers with your learning facilitator.

Activity 4: Pumps for Hydraulic Systems

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Pump: a device that is used to move a fluid

Another important part of a hydraulic system is the component that supplies the force that moves or compresses the fluid. This component is the **pump**. Pumps can be powered by electricity, gasoline engines, or by you.

Read page 110 in your textbook to find out more about pumps.

Investigation

Refer to Activity 2-18 on page 111 of your textbook.

1. Do questions 1. (a), (d), (e), and (f) on page 111.

   Textbook question 1. (a):

   _____

   _____

   Textbook question 1. (d):

   _____

   _____

Textbook question 1. (e):

Textbook question 1. (f):

2. List three examples where you are the source of power in a hydraulic system.

3. a. Aerosol spray cans do not have a pump in them. What causes the contents to spray out of the cans when the valve is depressed?

b. What feature must these spray cans have to make them safe to use? Why?

Check your answers with your learning facilitator.

Activity 5: Maintaining Fluid Systems

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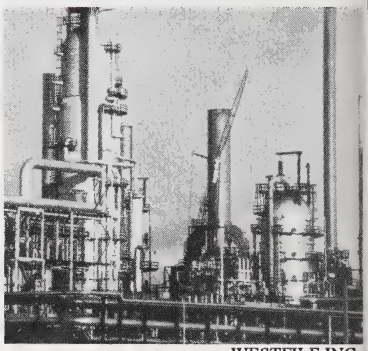


WESTFILE INC.

Fluid systems can be small, like a bicycle tire and pump system, or extremely large and complex, like a refinery.

Virtually every house is connected to every other house in North America by a natural gas pipeline. So the system of natural gas pipelines is an enormous fluid system.

Another very complex and large fluid system is your circulatory system. It has a pump and up to 100 000 km of pipelines, or blood vessels, in it.

9
Science Directions

Read pages 112 and 113 of your textbook to find out more about maintaining a fluid system.

1. Why is it important that the pressure in a fluid system be controlled and known?

2. Why do you think that it is unhealthy to have high blood pressure?

3. a. What are some of the problems that can occur in a fluid system?

   b. How are these problems solved?

Check your answers with your learning facilitator.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Hydraulic systems have fluids that move in confined spaces. The purpose of the systems may be to transmit forces or to move fluids from one place to another. There are natural hydraulic systems, such as the circulatory system, and human-made ones. There are various terms associated with hydraulic systems.

Match up the columns below by placing the letters from the second column in the appropriate space provided in the first column.

_____ 1. friction	a. something that controls the flow of liquid
_____ 2. heart	b. this makes fluid systems lose their pressure
_____ 3. pressure	c. a material often transported by pipeline
_____ 4. bicycle pump	d. an example of a pump containing four valves
_____ 5. hydraulic press	e. something that supplies the force to a system
_____ 6. pressure loss	f. where fluids are used to make work easier
_____ 7. natural gas	g. dirty pipes suffer from this
_____ 8. pumps	h. the force per unit of area in a system
_____ 9. valve	i. a pump where you supply the energy

Check your answers by turning to the Appendix, Section 5: Extra Help.

9 Science Directions

Enrichment

1. Do questions 6. (a) to (e) on page 105 of your textbook.

Textbook question 6. (a):

r_{large} =_____ cm

r_{small} =_____ cm

Textbook question 6. (b):

$A_{large} = \pi r^2$

= _____

$A_{small} = \pi r^2$

= _____

Textbook question 6. (c):

F = 10 N

A_{large} = _____ cm^2

$P_{large} = \frac{F}{A}$

=

P_{large} = _____ N/cm^2

F = 10 N

A_{small} = _____ cm^2

$P_{small} = \frac{F}{A}$

=

P_{small} = _____ N/cm^2

Textbook question 6. (d):

Textbook question 6. (e):

9 Science Directions

2. Answer questions 2. (b), (c), and (d) on page 111 of your textbook.

Textbook question 2. (b):

Textbook question 2. (c):

Textbook question 2. (d):

Share your answers with your learning facilitator.

Conclusion

You have learned how fluids are used and how their properties are applied to everyday situations. Fluids are used to lift weights and apply forces with relative ease. This property is used in car brakes and in the hydraulics of large pieces of construction equipment, as well as in many other places. Valves are essential to the operation of fluid systems because they allow the fluids to flow in a specific way. Pumps are the force behind most fluid systems. They are designed to move fluids and to apply pressure through fluids. Some fluid systems are essential to life, such as your circulatory system, and others are essential to your way of life, such as water and natural gas pipelines.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 5.

Assignment Booklet

MODULE SUMMARY

This module has introduced you to the group of substances called fluids. These include liquids and gases, and are characterized by the fact that they can flow. The viscosity, or ease of flow, of different fluids varies depending on whether they are gases or liquids, what their temperature is, and what their composition is.

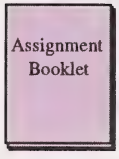
Different fluids have different densities, resulting in different buoyant forces. The sinking and floating of objects and materials in fluids depends on the buoyant force applied by the fluids. The instrument used to measure the density of fluids is a hydrometer.

Gases are compressible and liquids are incompressible. Because of this, a confined liquid can be used to transfer a force directly. A gas can also be used to transfer a force, but it is less direct. The pressure in a fluid system is applied in all directions.

Barometers are used to measure air pressure. The hydraulic press is one practical application of the use of fluids under pressure to do work. Hydraulic presses are used in machines like car jacks, hydraulic lifts, and brake systems.

Transport systems for fluids are based on the a detailed understanding of fluid behaviour, such as the fluid's viscosity, density, corrosiveness, and sensitivity to temperature changes.

You have found out that fluids and pressure apply in many situations – from inflating your bicycle tire to drinking a milk shake, and from pouring ketchup on your french fries to paddling a canoe.



ASSIGNMENT

Turn to your Assignment Booklet and do the Final Module Assignment.

Appendix

Glossary

Barometer	• an instrument used to measure air pressure
Buoyancy	• the tendency of an object or material to float in a fluid
Buoyant force	• the upward force of a fluid on another object or material
Density	• the mass in a certain volume of an object or material
Displace	• to push aside or out of a position
Fluid	• any substance that can flow; a gas or liquid
Hydraulic press	• a machine that works because of the movement of a fluid or the force of a fluid in a closed system
Hydrometer	• a floating device used to measure the density of fluids
Pump	• a device that is used to move a fluid
Streamlined	• shaped to reduce resistance to motion through a fluid
Valve	• a device that controls the size of an opening to control the flow of a fluid
Viscosity	• a measure of how easily a fluid flows; resistance to flow

Suggested Answers

Section 1: Activity 2

1. The times for the air-filled syringe should be less than those for the water-filled syringe. For air, times will average about 1 second, for water they will vary from 3 to 7 seconds.

   The following chart contains sample data.

Fluid	Trial	Time (s)
Air	1	1
	2	1
	3	2
Water	1	5
	2	6
	3	4

2. The piston in the air-filled syringe moved down faster than the piston in the water-filled syringe. Water flows more slowly than air.

Section 1: Activity 3

1. It is easier to walk through air than through water. Airplanes and cars are able to travel much more quickly than boats and submarines. Any answer that shows that air flows more easily than water is acceptable.

2. An object can move through air more easily than it can move through water. The previous investigation showed that air flows and can be pushed aside more easily than water. So a boat that is designed to go mostly through the air, like a hydrofoil, will be able to travel more easily and quickly than a boat that is designed to go through the water.

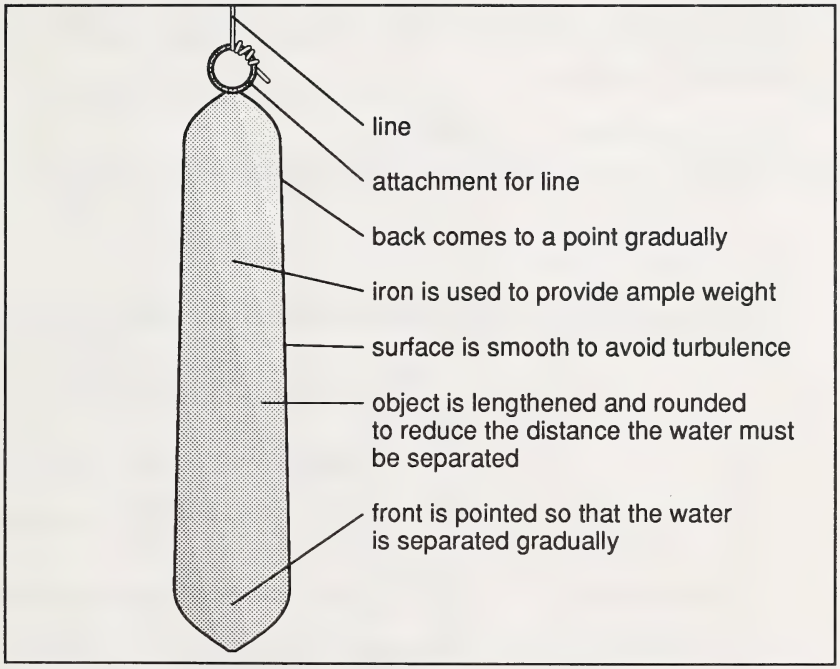
3. The word used to describe how fast or slow a fluid flows is _____viscosity_____.

4. Your answer will be unique, but the following answer is suitable.

   Molasses flows more slowly than water because it has a higher viscosity.

5. The front of the van has been slanted so that the air is pushed up and out of the way as the van moves. If the front is nearly straight up and down, the air builds up in front of the van and pushes back against it when it is moving. If the air is pushed upwards out of the way, there is less air resisitance.

6. You should draw a weight with a streamlined shape. You may have made the back less dense than the front so that the weight has a greater tendency to drop straight down. A sample answer follows.


line
attachment for line
back comes to a point gradually
iron is used to provide ample weight
surface is smooth to avoid turbulence
object is lengthened and rounded to reduce the distance the water must be separated
front is pointed so that the water is separated gradually

Section 1: Follow-up Activities

Extra Help

In this section you have been examining the types of matter called _____fluids_____. They are substances that _____flow_____, as water does in a river or through a hose. Fluids include both _____liquids_____ and _____gases_____.

Gases flow more _____quickly_____ than liquids. For example, the flow of water is _____slower_____ than the flow of air.

The speed that fluids flow at is called their viscosity; high viscosity means that the fluid flows slowly, low viscosity means that the fluid flows quickly.

Finally you found that temperature has an effect on the viscosity of a liquid. As it is heated up, the viscosity decreases. Keep in mind that you are not referring to the melting or freezing of a substance.

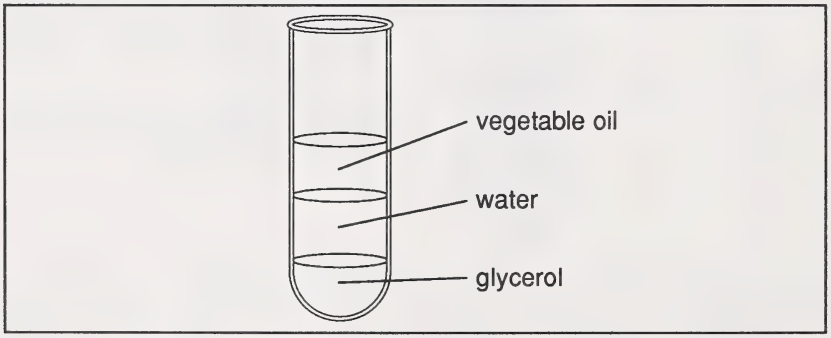
Section 2: Activity 3

1. a. The top liquid is vegetable oil.

   b. The middle liquid is water.

   c. The bottom liquid is glycerol.

   It is important that you make some prediction It is not important that the prediction is accurate.

2. 

3. You are to fill in the table using the data that you have collected in the previous activity. The two columns should have the same order of liquids, as shown.

Liquid According to Position in the Test Tube	
Top	**vegetable oil**
Middle	**water**
Bottom	**glycerol**

Liquid According to Buoyant Force	
Least	**vegetable oil**
Middle	**water**
Greatest	**glycerol**

4. You are to explain what evidence there is to suggest that one liquid exerts a greater buoyant force than the others.

   A sample response could be as follows:

   The glycerol exerted the greatest buoyant force because it was able to displace both the water and the vegetable oil in the test tube. Of the three liquids, it also made the 500-g mass lose the most weight because it applied the greatest buoyant force on the weight.

5. Buoyancy is an upward force on an object in a fluid caused by the displacement of the fluid by the object. The size of the force is related to the amount of the fluid displaced.

6. a. One gas can displace another gas. ___T___

   b. The buoyancy of a liquid on a solid depends on the volume of the liquid displaced by the solid. ___T___

   c. The buoyant force on an object depends on the type of liquid used. ___T___

   d. One liquid can displace another liquid. ___T___

Section 2: Follow-up Activities

Extra Help

In the first activity you learned that one ___gas___ can push aside, or ___displace___, another. The carbon dioxide exerted a ___buoyant___ force on the air and pushed it up and out of the way.

In the second activity you showed that objects put into water ___appear___ to lose ___weight___. The apparent ___loss___ in weight is called the buoyant ___force___ exerted on that object. Buoyant force is measured in ___newtons___ and is always an ___upward___ force.

In the third activity you learned that liquids can exert a buoyant force on other ___liquids___. The liquid that exerted the greatest buoyant force is at the ___bottom___ of the test tube. The liquid that exerted the ___smallest___ buoyant force is at the ___top___ of the test tube.

Section 3: Follow-up Activities

Extra Help

Density is the comparison of an object's ___mass___ with its ___volume___. For example, feathers have a ___low___ density and lead has a high ___density___. Things float in water if they have a density of ___less___ than 1 g/mL. Mercury is a very dense ___liquid metal___. It exerts a very strong ___buoyant___ force on an object. One of the few materials that will sink in mercury is ___gold___. This is because the density of gold is ___19.32 g/mL___, compared to ___13.55 g/mL___ for mercury. A ___hydrometer___ is an instrument that is used to ___measure___ the density of a ___liquid___. It floats ___higher___ in dense liquids and ___lower___ in less dense liquids. Ice floats on water because its density is less than ___1 g/mL___.

Section 4: Activity 2

1. a. The pressure increases when the skates are put on because the area of the skate blade is much less than the area of the boot soles. So with the decreased area and the same force, the pressure increases.

   b. The pressure on the snow increases because the area of the ski bottoms stays the same, but the force on the skis increases, so the pressure increases.

2. The basic unit of pressure is the ___pascal___. It is equal to 1 ___N___ / ___m^2___.

3. The more common pressure unit is the ___kilopascal___.

4. What is the pressure at the bottom of a cubic metre of water? Give an answer for both Pa and kPa. ___10 kPa___ or ___10 000 Pa___.

5. Fluid pressures act in all directions, sideways, up and down. The textbook photographs on page 94 help to illustrate this fact.

Section 4: Follow-up Activities

Extra Help

Pressure is the amount of ___force___ applied over a certain ___area___. To make a garden hose shoot the water further, you can either ___increase___ the force or ___decrease___ the area of the opening. When pressure is applied to ___gases___, they decrease in volume. That means that gases are ___compressible___. Liquids ___do not___ change in volume when pressure is applied to them. They are ___incompressible___. Compressible fluids are used in ___tires___, ___aerosol cans___, and ___submarines___. Incompressible fluids are used in ___water pistols___, ___garden hoses___, and ___your heart___. The metric unit for pressure is the ___pascal___. It is defined as 1 ___N/m^2___. The direction of the force of ___pressure___ in a fluid is in ___all directions___. The air pressure decreases as you go up in the atmosphere because there is ___less air___ above you to apply pressure. An instrument that measures air pressure is called a ___barometer___.

Section 5: Activity 1

1. The problem can be stated as follows: Can a hydraulic press transfer force and change its strength?

2.

Size of Piston		Force Required
Effort (thumb)	Load (1 kg mass)	
same area	same area	standard force
smaller area	larger area	**less than**
larger area	smaller area	**more than**

3. Applying the effort to the smaller syringe and setting the 1 kg load on the larger syringe was the arrangement that required the least force to raise the weight.

4. The investigation suggests the following relationship: The smaller the area of the effort syringe, as compared to the load syringe, the less effort is required to lift the load.

5. The smaller piston moved farther than the larger piston.

Section 5: Follow-up Activities

Extra Help

b	1. friction	a.	something that controls the flow of liquid
d	2. heart	b.	this makes fluid systems lose their pressure
h	3. pressure	c.	a material often transported by pipeline
i	4. bicycle pump	d.	an example of a pump containing four valves
f	5. hydraulic press	e.	something that supplies the force to a system
g	6. pressure loss	f.	where fluids are used to make work easier
c	7. natural gas	g.	dirty pipes suffer from this
e	8. pumps	h.	the force per unit of area in a system
a	9. valve	i.	a pump where you supply the energy

Science 9

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